REMARKS

Claims 18, 19, and 22-26 are pending in the application. This Amendment currently amends claim 22 and adds new claim 26. Claims 20 and 21 are canceled without prejudice or disclaimer. No new matter is added to currently amended claim 22 or to new claim 26. Claim 22 is currently amended to merely clarify the subject matter of the claims and in no way narrow the scope of the claims in order to overcome the prior art or for any other statutory purpose of patentability. Reconsideration in view of the foregoing amendments and the following remarks is respectfully requested.

Notwithstanding any claim amendments of the present Amendment or those amendments that may be made later during prosecution, Applicants' intent is to encompass equivalents of all claim elements.

Claims 22-25 stand rejected under 35 U.S.C. §112, second paragraph.

Claims 22-25 stand rejected under 35 U.S.C. §112, first paragraph.

Claims 20 and 21 stand rejected under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 5,578,839 to Nakamura et al. (hereinafter, Nakamura). By this Amendment, claims 20 and 21 are canceled without prejudice or disclaimer; hence, the rejection of claims 20 and 21 is moot.

Claims 22-25 stand rejected under 35 U.S.C. §102(b) as anticipated by Nakamura. Applicants respectfully note that claim 22 is a method claim corresponding to the device claim of U.S. Patent No. 6,005,258, which is the grandparent application of the present patent application; hence, the claim should not be rejected under 35 U.S.C. §102(b).

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention, as defined in claim 22, is directed to a method for producing a light-emitting semiconductor device of a group III nitride compound that comprises forming an N-layer of an N-type conduction, the N-layer comprising gallium nitride, forming an emission layer of a group III nitride compound semiconductor satisfying the formula, $Al_{x1}Ga_{y1}In_{1-x1-y1}N$,

where $0 \leq x1 \leq 1$, $0 \leq y1 \leq 1$, and $0 \leq x1+y1 \leq 1$, on the N-layer, forming a P-layer of a P-type conduction, on the emission layer, the P-layer comprising aluminum gallium nitride satisfying the formula, $Al_{x2}Ga_{1-x2}N$, where $0<x2<1$, and forming a contact layer of P-type conduction, on the P-layer, the contact layer comprising gallium nitride.

II. THE PRIOR ART REJECTIONS

With respect to claim 22, Nakamura does not disclose forming a layer made of n-GaN, an emission layer made of AlGaInN, and a layer made of p-AlGaN.

Fig 10 of the Specification shows a device of laminated layers comprising: an Si-doped n-GaN layer; a GaN layer formed on the n-GaN layer; and an Mg-doped p-AlGaN layer formed on the GaN layer. The GaN layer is an emission layer.

Forming the base layer with GaN enables the emission layer to maintain its crystallization, and forming the upper layer with AlGaN prevents injected electrons from diffusing. Accordingly, an effective emission can be obtained. A special combination of n-GaN and p-GaN is unique in n-type and p-type cladding layers of the present invention.

Embodiments of Nakamura disclose heterostructures which are symmetric with each other with respect to the n-type cladding layer and the p-type cladding layer. In column 5, lines 14-32, Nakamura only discloses general composition ratios of an n-type cladding layer and a p-type cladding layer as $Ga_yAl_{1-y}N$ (inclusive of $0 \leq y \leq 1$) and $Ga_zAl_{1-z}N$ (inclusive of $0 \leq z \leq 1$), respectively.

Thus, forming an asymmetrical structure with respect to the widths of energy bands of the N-layer and the P-layer is not obvious over forming the symmetrical structure of Nakamura.

Exhibits 1A and 1B attached herewith, show band structures characteristic of a not applying a forward voltage and applying a forward voltage, respectively.

According to Exhibit 1B, electrons are injected into the emission layer 1 from the n-type cladding layer 2, and holes are injected into the emission layer 1 from the p-type cladding layer 3. Before they are influenced by a scattering caused by phonons, or a non-emission transition, recombination of the electrons and holes occurs and the emission layer emits light thereby. The

higher the concentrations of electrons and holes in the emission layer 1, the stronger the light becomes.

The cladding layer 3 prohibits the injected electrons from diffusing into the p-type cladding layer 3 without recombining with the injected holes, and also the cladding layer 2 prohibits the injected holes from diffusing into the n-type cladding layer 2 without recombining with the injected electrons. And the cladding layers 2 and 3 heighten concentrations of electrons and holes, which contribute to their recombination in the emission layer 1.

It has been known that a mean free path of electrons, or mean value of the movable distance without phonon scattering, is longer than that of holes. Because of that, electrons can move in the emission layer nearer to the barrier of the p-type cladding layer 3, without being influenced by phonon scattering. On the other hand, because holes are relaxed by phonon scattering before they diffuse near the barrier of the n-type cladding layer 2, they do not contribute to emission of light. In short, holes need to meet electrons before the holes are scattered by phonons, and the portion which emits light is placed near the p-type cladding layer 3.

Accordingly, confining electrons effectively by the barrier Be of the p-type cladding layer 3 is more important than confining holes by the barrier Bh of the n-type cladding layer 2. To strengthen the electric potential barrier for electrons, it is more effective to use AlGaN, which has a broader band width, for forming the p-type cladding layer 3, instead of using GaN.

But there remains a problem. In the case where the n-type cladding layer 2 is AlGaN which has a higher barrier, AlGaN is inferior in crystallization compared to GaN, and so the crystallization of the emission layer 1 formed on the n-type cladding layer becomes worse. Consequently, it is better that GaN is used as the n-type cladding layer 2 on the substrate side, to improve the luminous intensity of the emission layer because a higher barrier is not needed in the n-type cladding layer 2.

III. THE 35 U.S.C. §112, FIRST AND SECOND, PARAGRAPH REJECTIONS

The Office Action rejects claims 22-25 under 35 U.S.C. §112, second paragraph, because the Office Action alleges there is not support or antecedent basis for the limitation, "[w]herein a bandwidth of the N-layer is narrower than the bandwidth of the P-layer, potential barrier of a valence band of the N-layer is lower than a potential barrier of a conduction band of the P-layer," in claim 22.

By this Amendment, the aforementioned limitation is deleted from claim 22; hence, the rejection of claim 22 and claims 23-25, which depend from claim 22, under 35 U.S.C. §112, second paragraph, is moot. Withdrawal of the rejection of claims 22-25 under 35 U.S.C. §112, second paragraph, is respectfully solicited.

The Office Action rejects claims 22-25 under 35 U.S.C. §112, first paragraph. The Office Action alleges that the limitation of claim 22, "[w]herein a bandwidth of the N-layer is narrower than the bandwidth of the P-layer, potential barrier of a valence band of the N-layer is lower than a potential barrier of a conduction band of the P-layer," contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the Application was filed, had possession of the claimed invention.

By this Amendment, the aforementioned limitation is deleted from claim 22; hence, the rejection of claim 22 and claims 23-25, which depend from claim 22, under 35 U.S.C. §112, first paragraph, is moot. Withdrawal of the rejection of claims 22-25 under 35 U.S.C. §112, first paragraph, is respectfully solicited.

IV. INFORMAL MATTERS AND CONCLUSION

As a convenience to the Examiner, attached hereto is a legible photocopy of each foreign patent document that was included in the Information Disclosure Statement filed on July 12, 2002. Another photocopy of the PTO 1449 form is also included for the Examiner's convenience. Applicants respectfully request that the attached documents be considered.

In view of the foregoing, Applicants submit that claims 18, 19, and 22-26 all the claims

condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 10/28/03

Peter A. Balnave
Reg. No. 46,199

McGinn & Gibb, PLLC
8321 Old Courthouse Road
Vienna, Virginia 22182-3817
(703) 761-4100
Customer No. 21254